US009194071B2

(12) **United States Patent**
Seo et al.

(10) **Patent No.: US 9,194,071 B2**
(45) **Date of Patent: Nov. 24, 2015**

(54) **PULSATOR DEVICE FOR WASHING MACHINES AND WASHING MACHINE HAVING THE SAME**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 1245 days.

(21) Appl. No.: **13/064,764**

(22) Filed: **Apr. 13, 2011**

(65) **Prior Publication Data**

US 2011/0296876 A1 Dec. 8, 2011

(30) **Foreign Application Priority Data**

Jun. 7, 2010 (KR) 10-2010-0053391

(51) **Int. Cl.**
D06F 13/00 (2006.01)
D06F 13/08 (2006.01)
D06F 17/10 (2006.01)

(52) **U.S. Cl.**
CPC ***D06F 13/08*** (2013.01); ***D06F 17/10*** (2013.01)

(58) **Field of Classification Search**
CPC D06F 17/06; D06F 17/10; D06F 13/08; D06F 37/225; D06F 13/00
USPC 68/133, 134, 131, 23.2, 23.6, 212, 53, 68/142, 23.7; 312/228
See application file for complete search history.

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(57) **ABSTRACT**

A pulsator device in which a second pulsator performs different movements according to rotating directions of a first pulsator so as to reduce water consumption and improve washing performance.

20 Claims, 16 Drawing Sheets

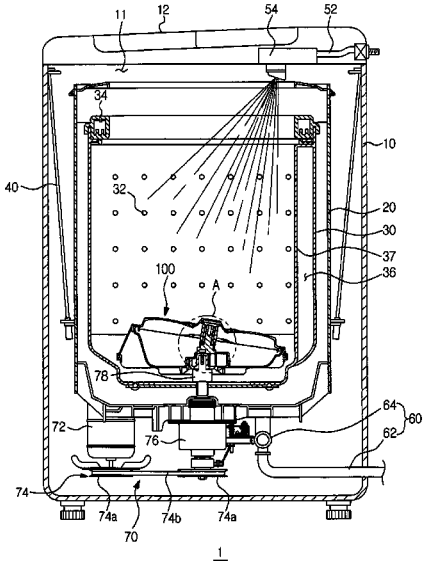

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FIG. 1

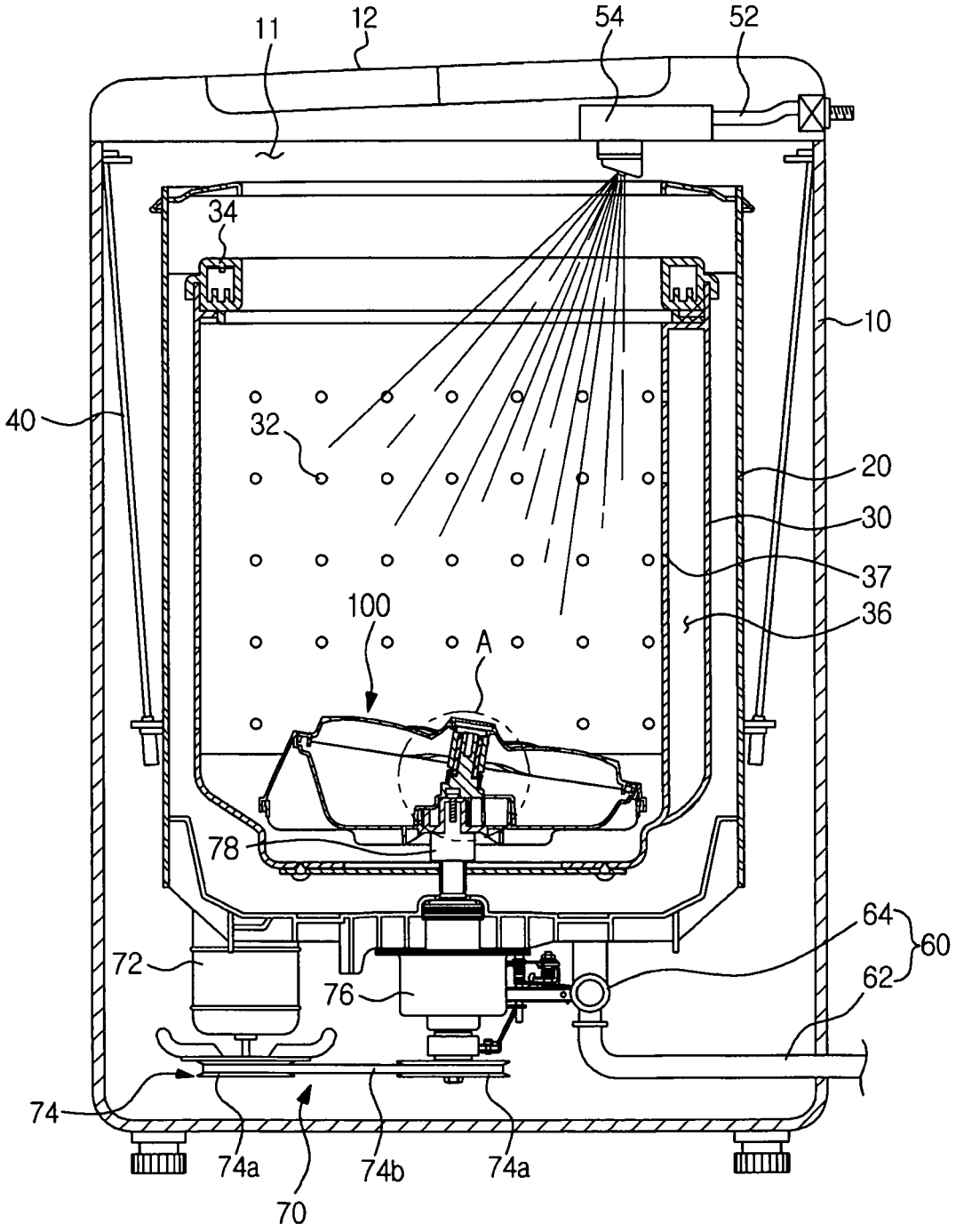
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FIG. 2

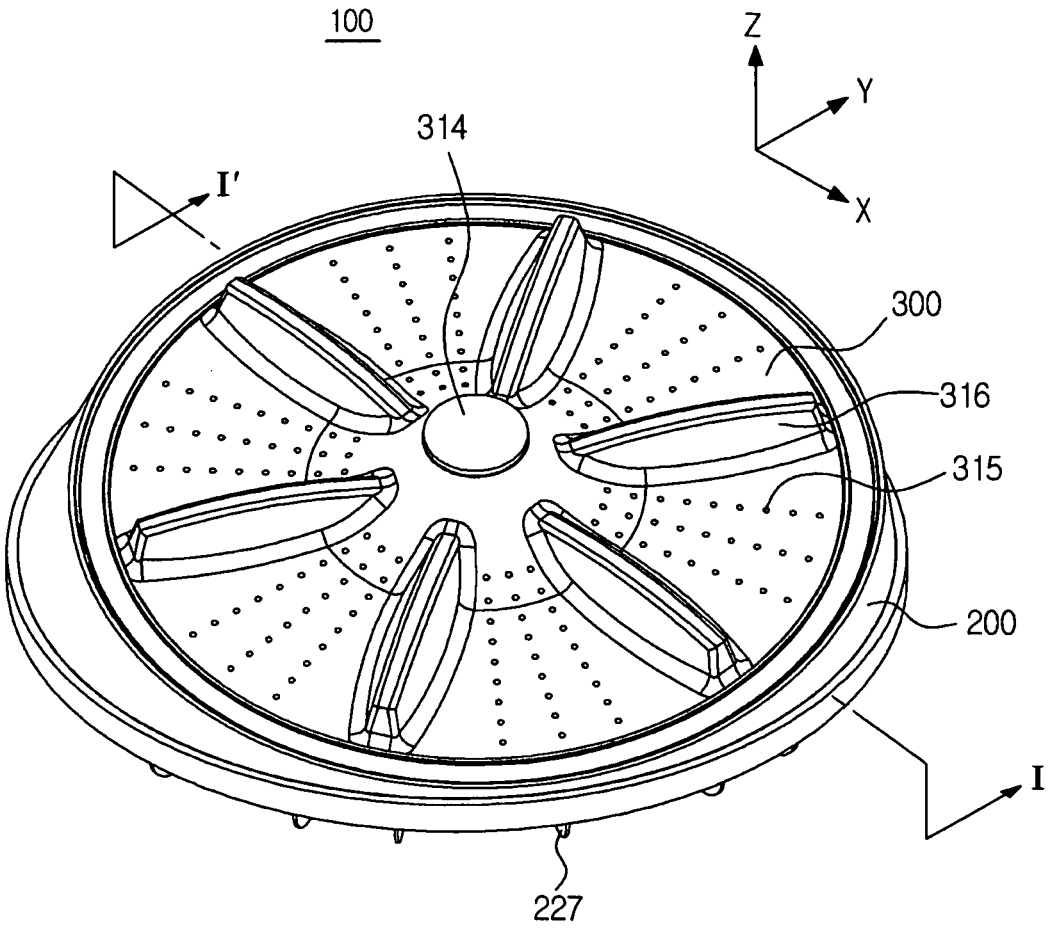

FIG. 3

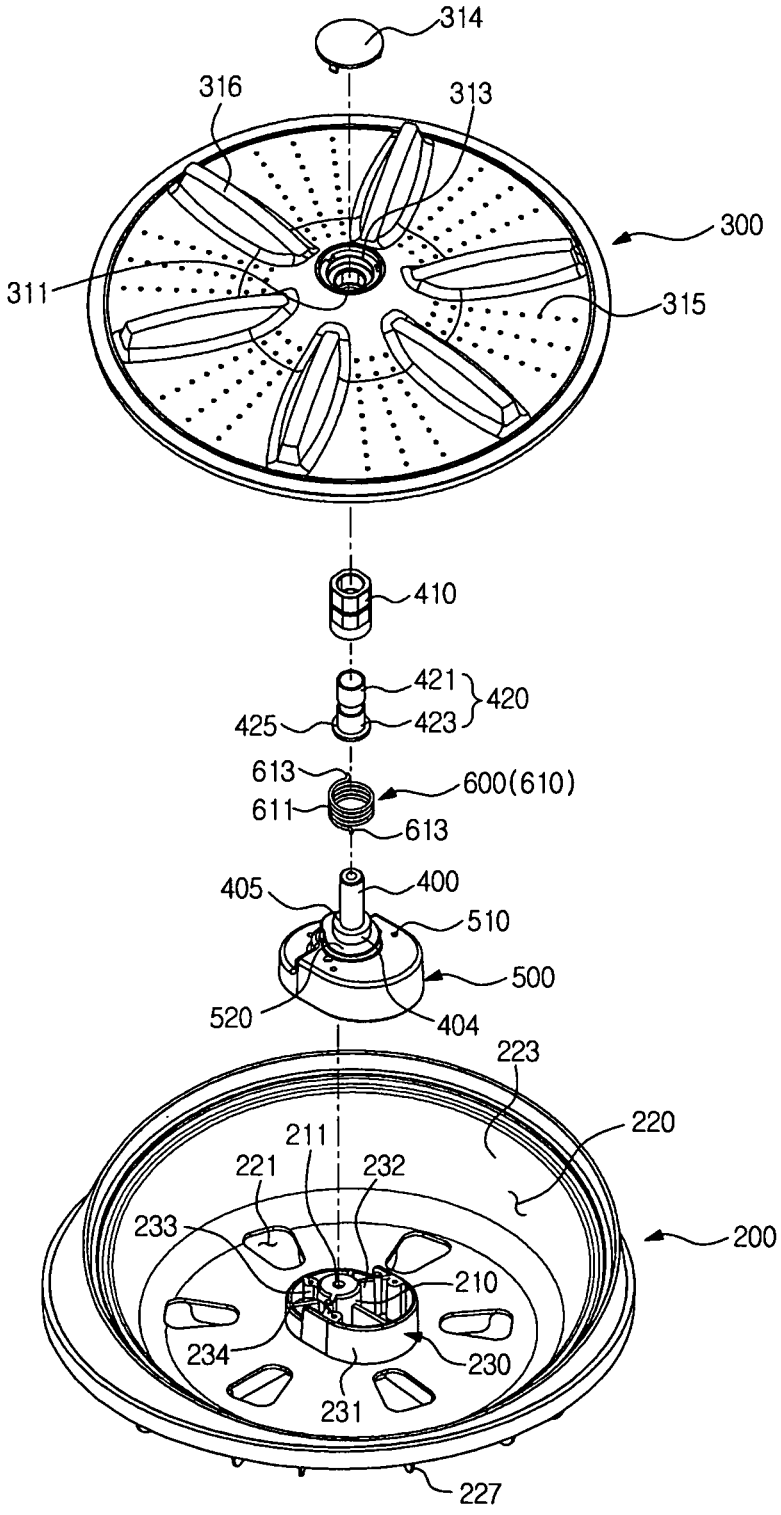
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FIG. 4

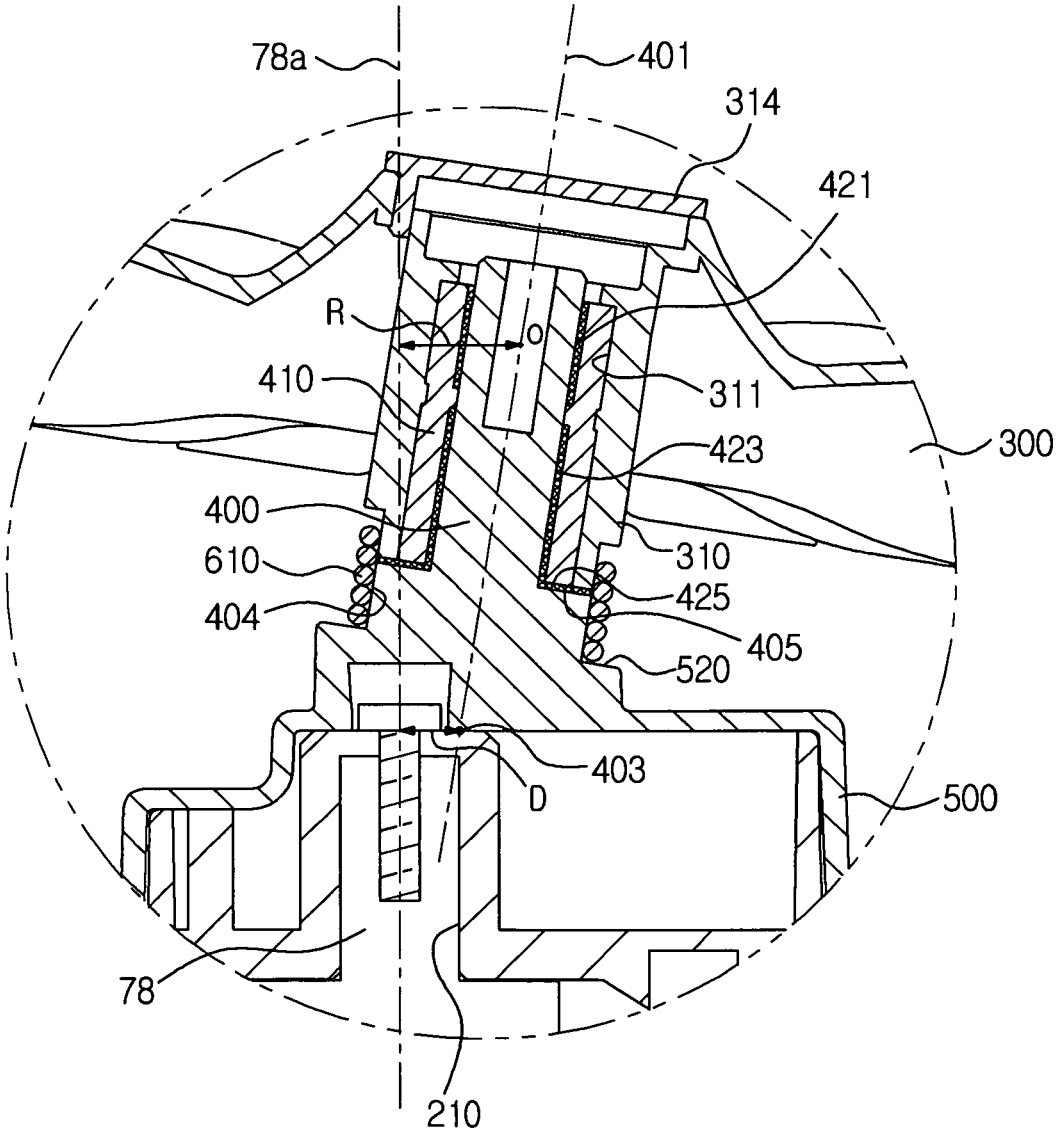
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FIG. 5A

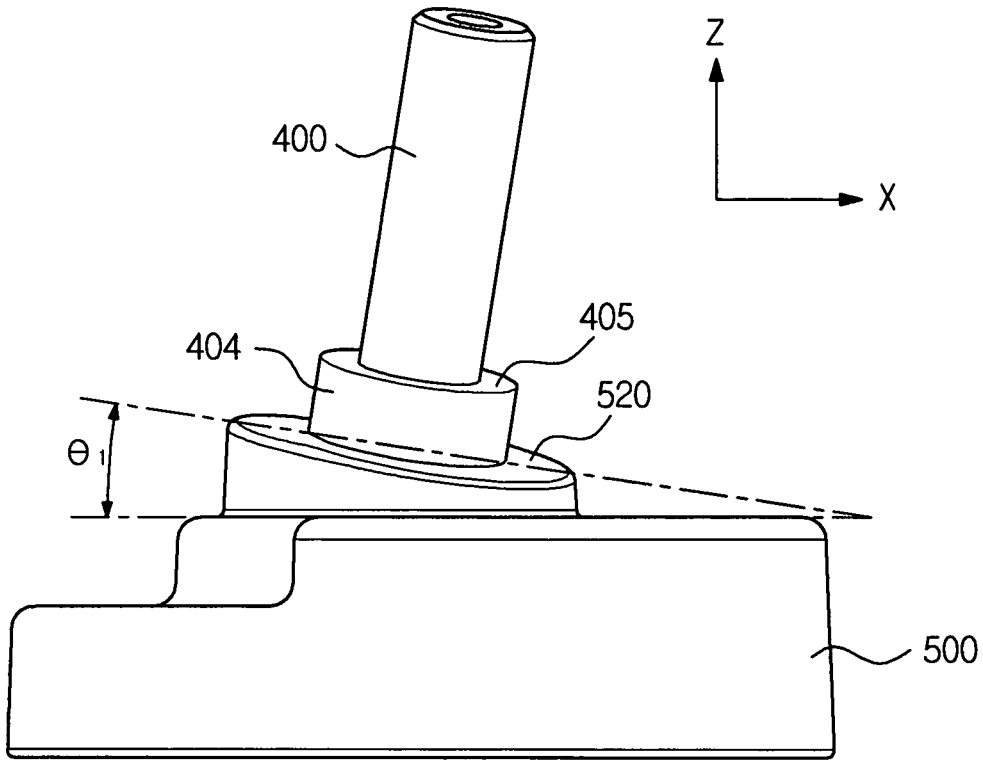

FIG. 5B

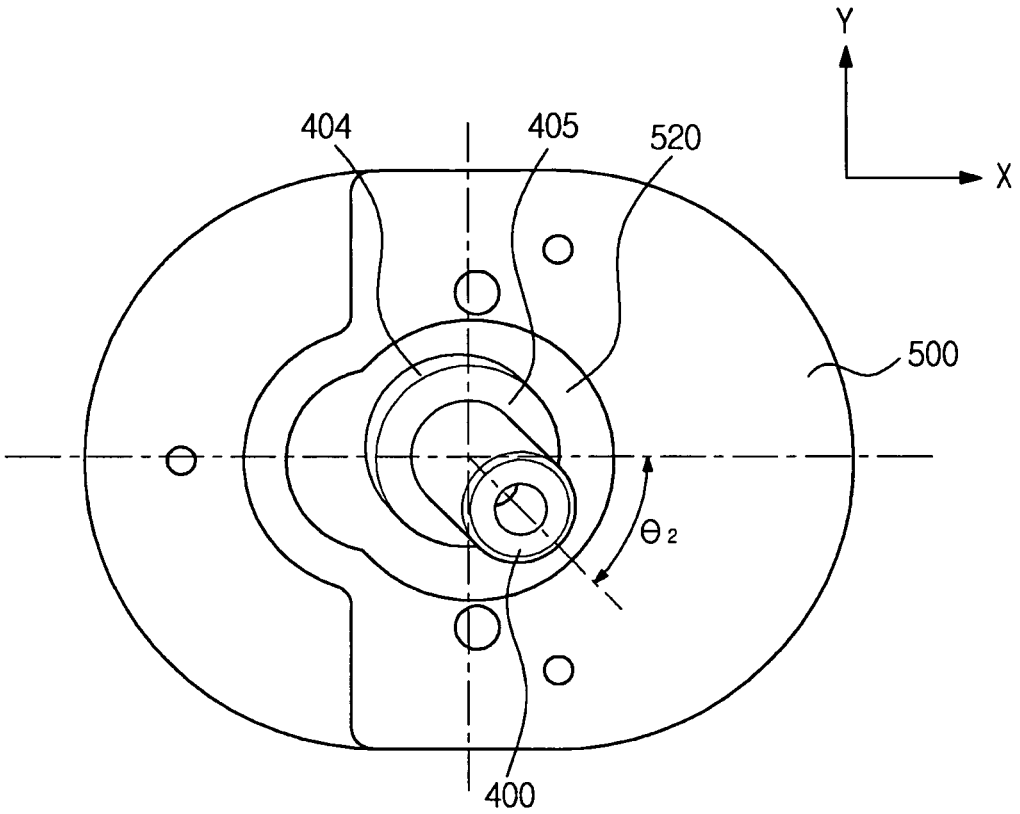

FIG. 6

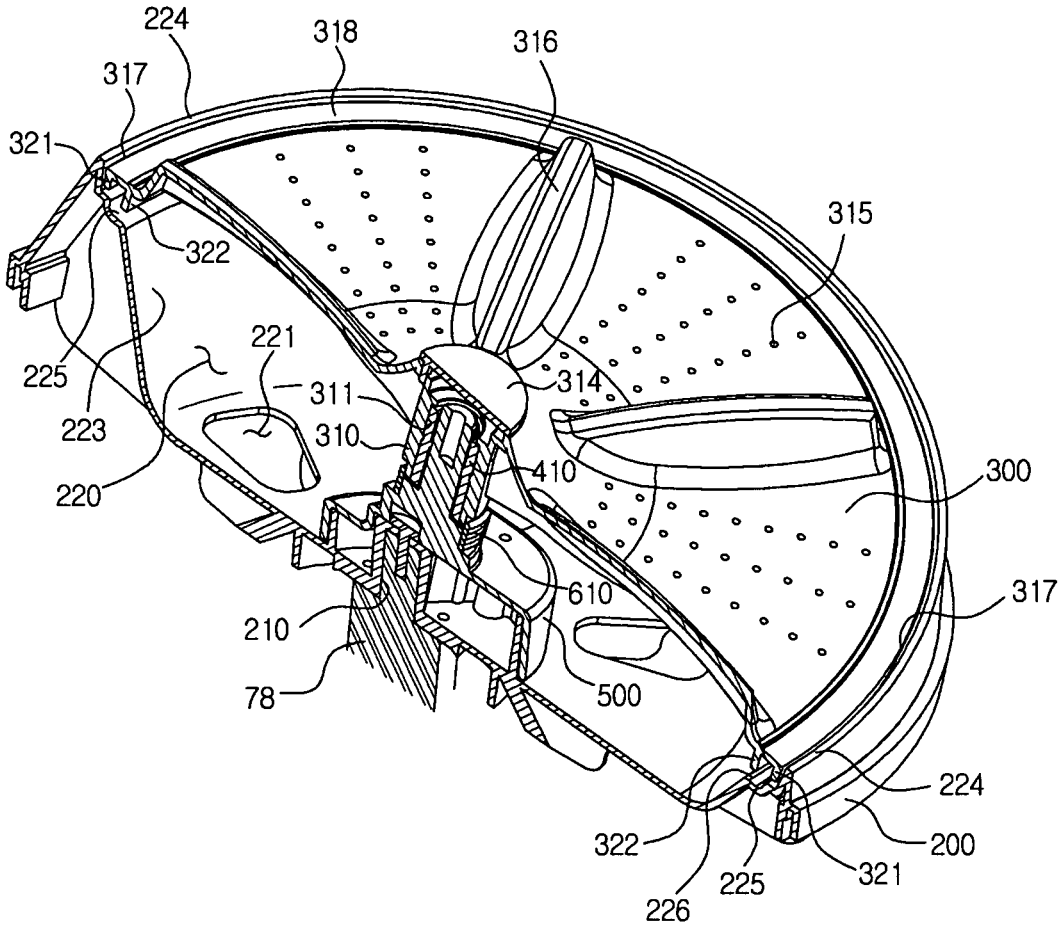
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FIG. 7

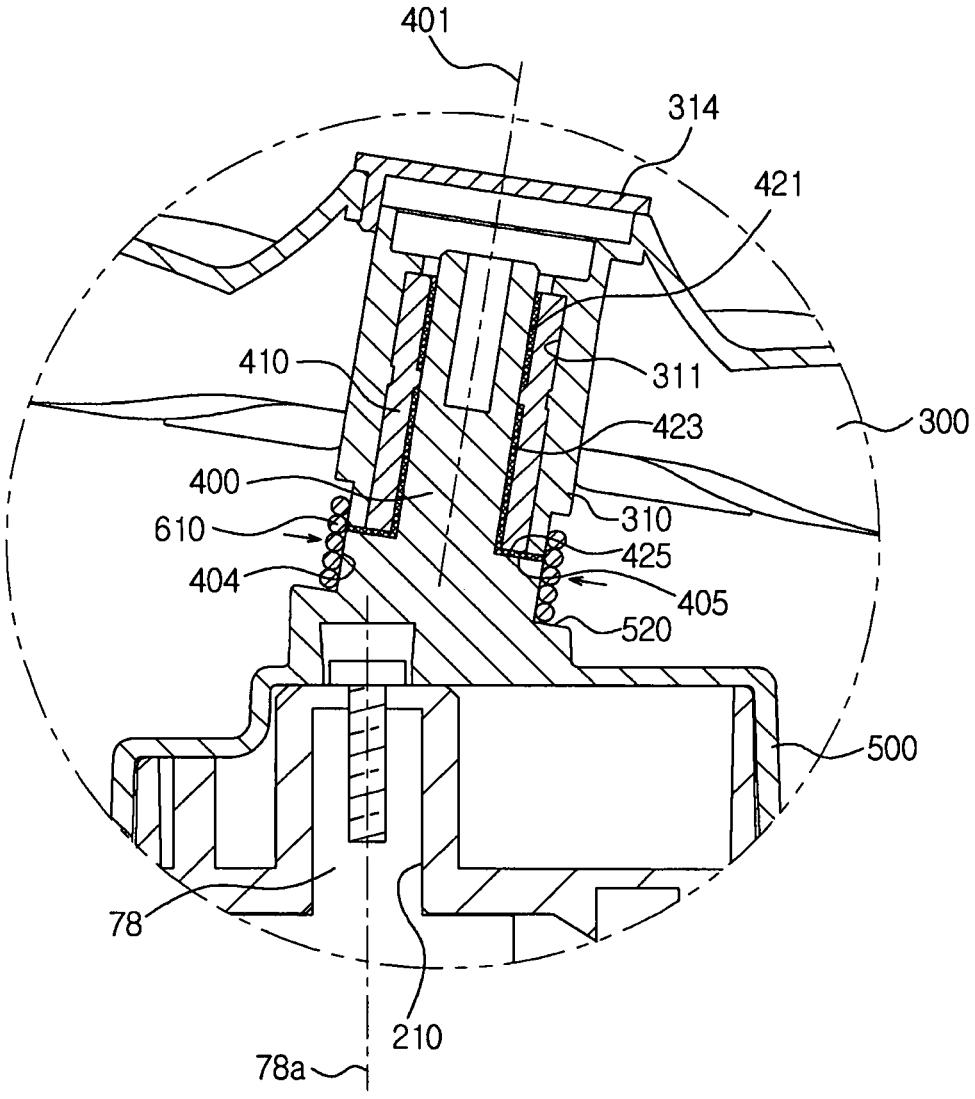
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FIG. 8

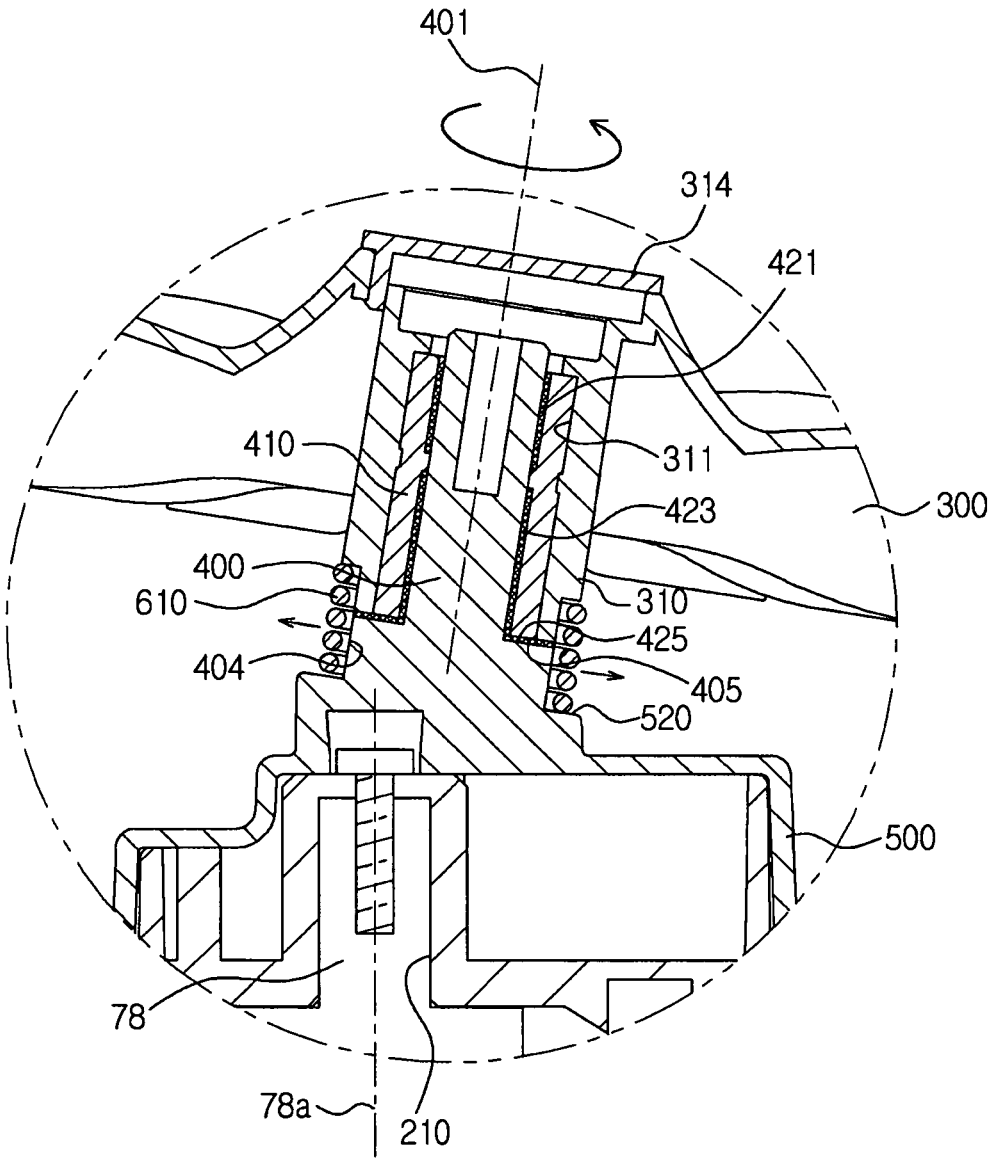
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FIG. 9

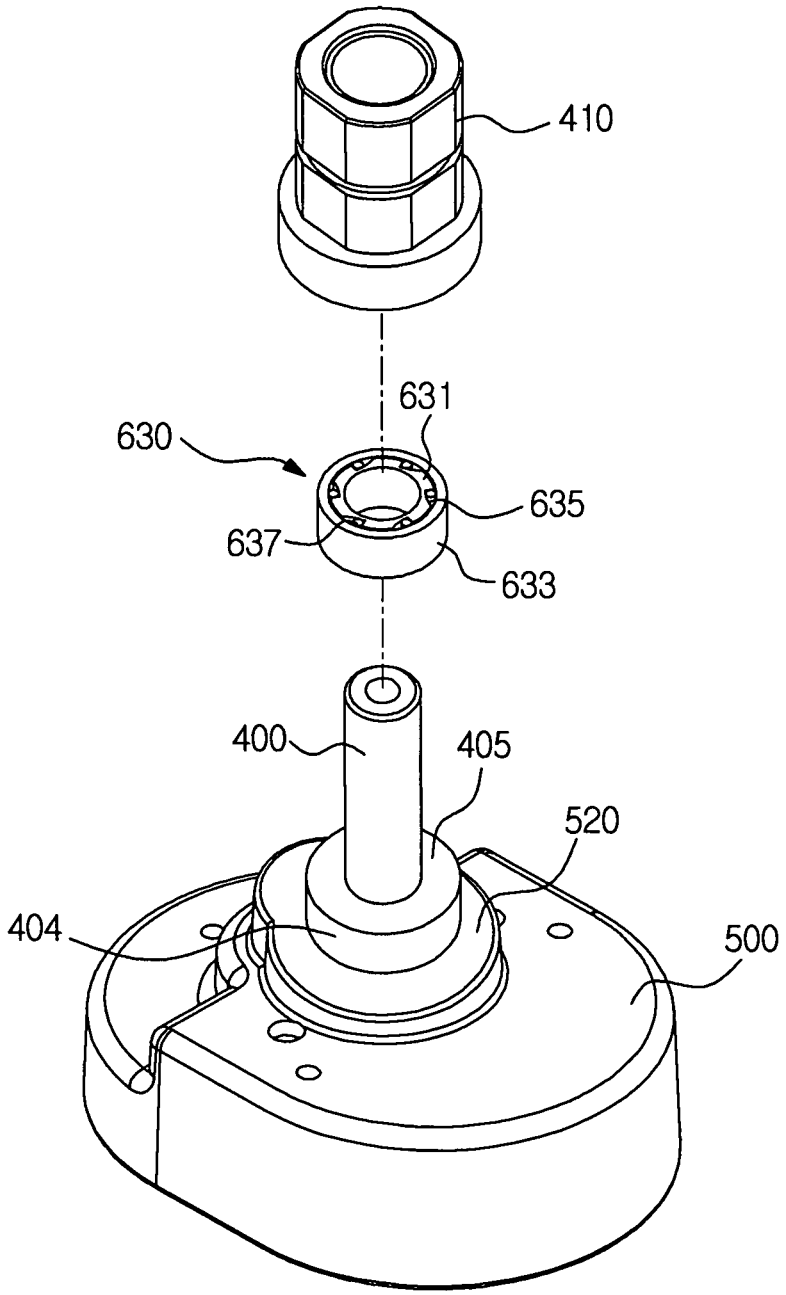


FIG. 10

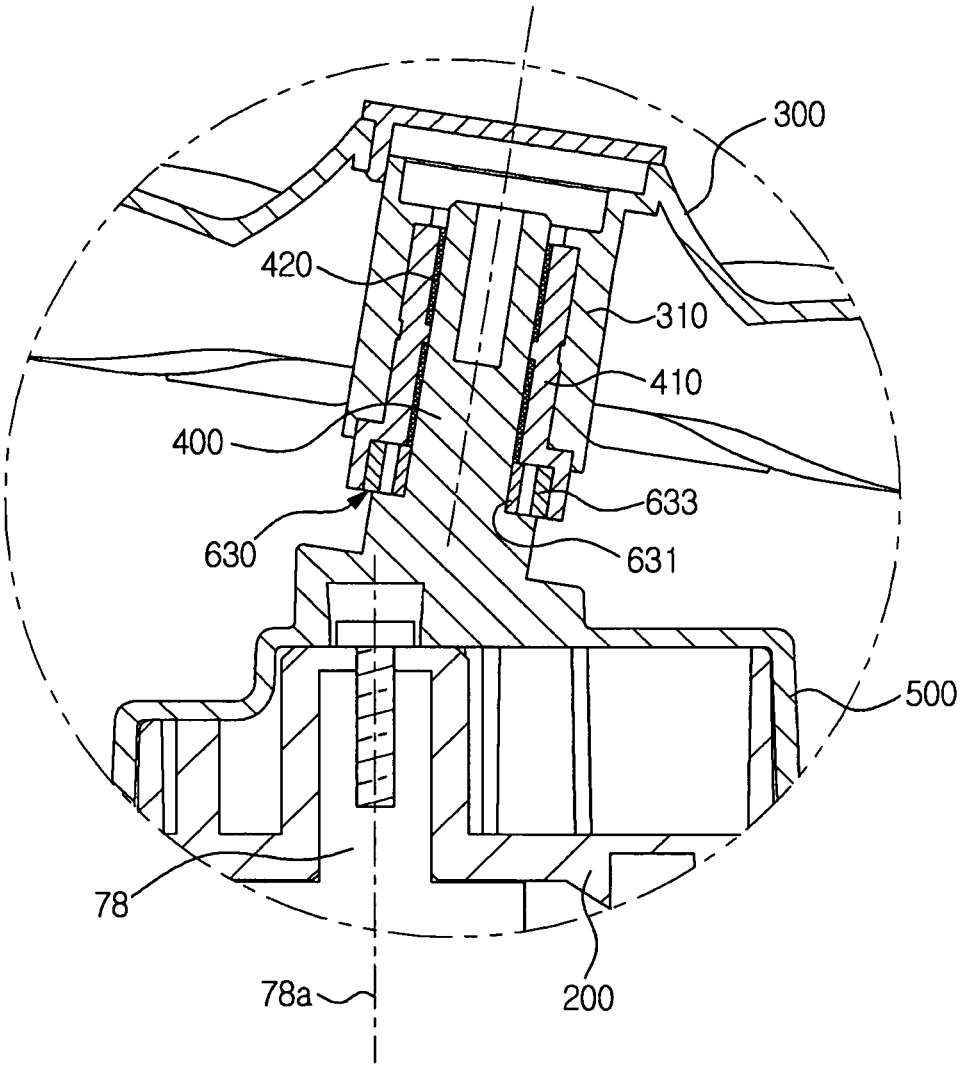


FIG. 11

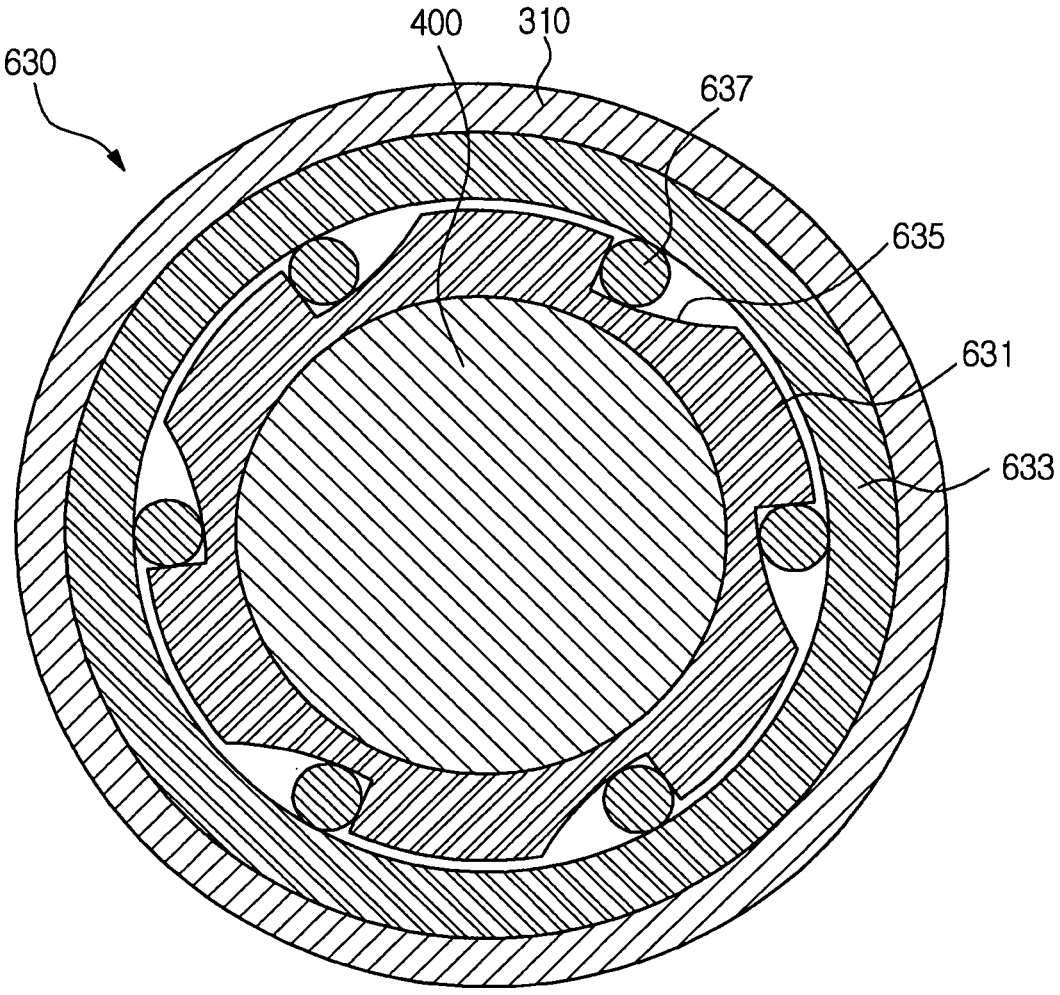


FIG. 12

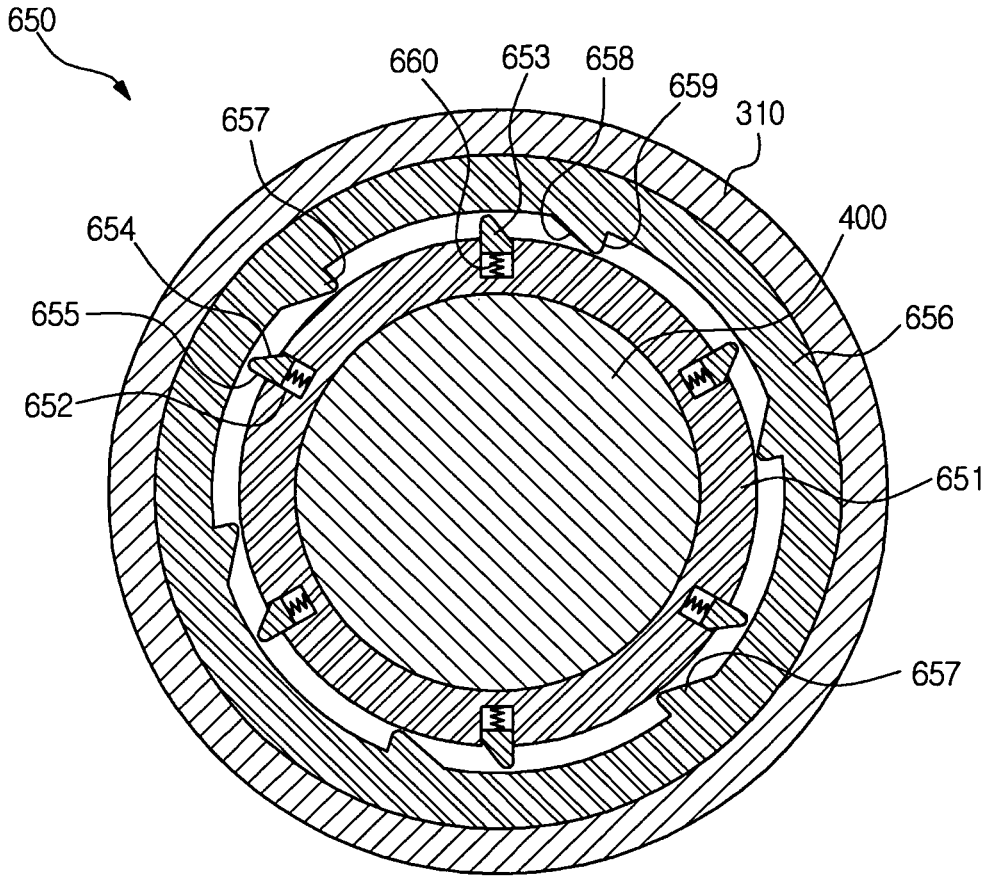


FIG. 13

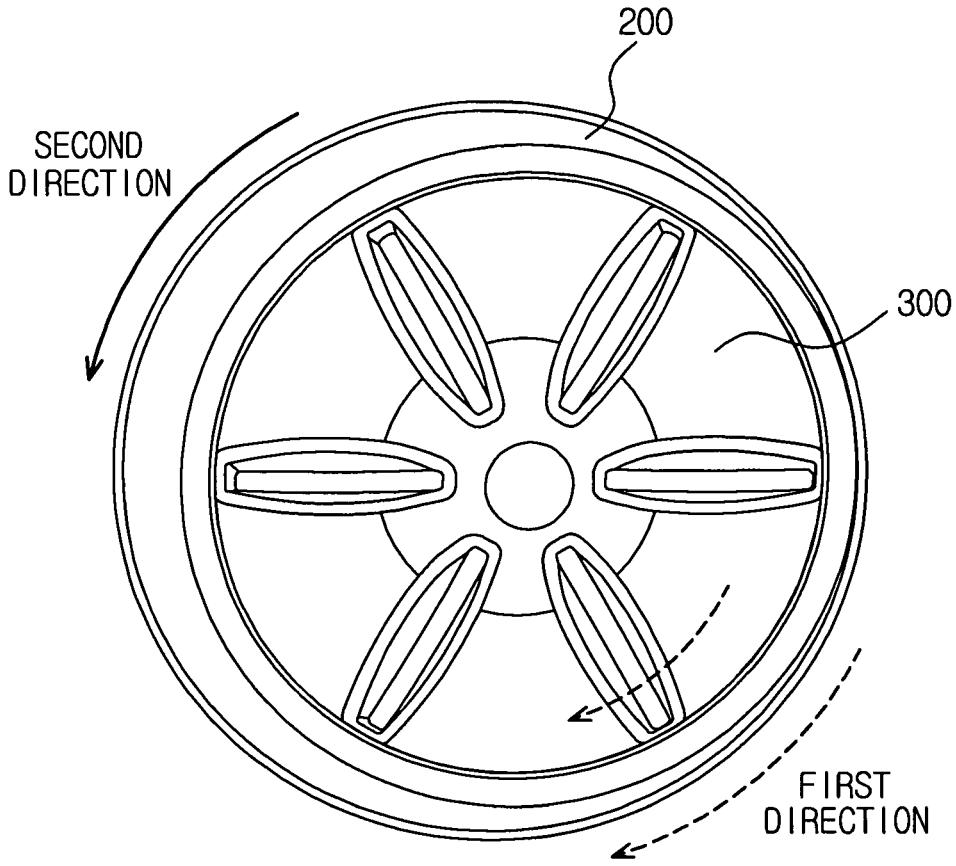


FIG. 14

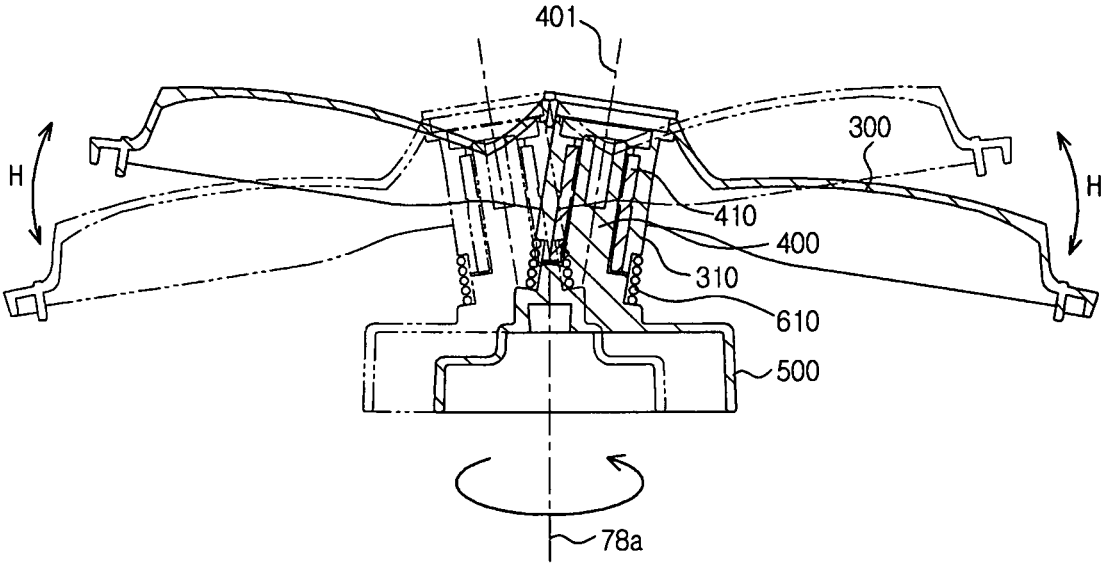
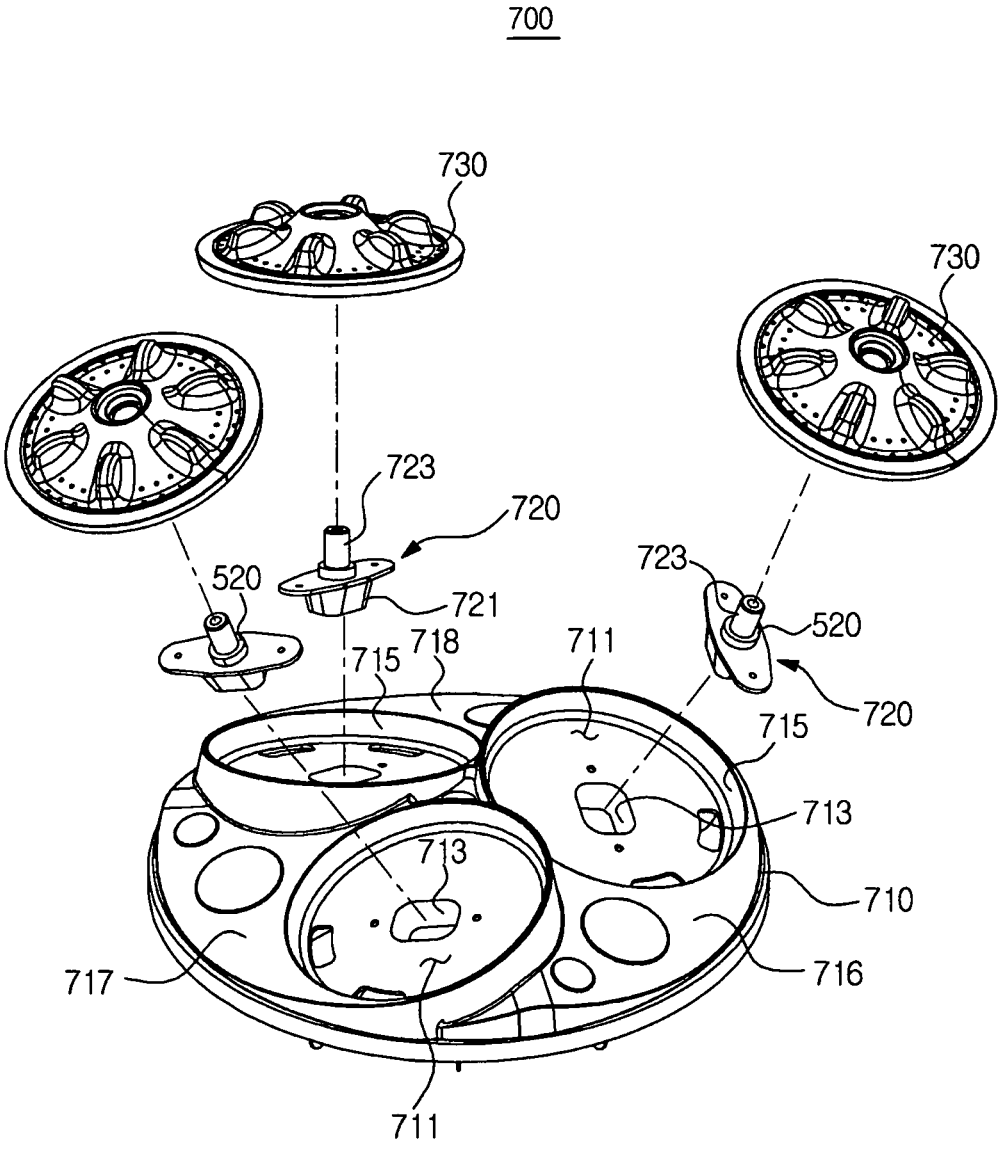


FIG. 15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PULSATOR DEVICE FOR WASHING MACHINES AND WASHING MACHINE HAVING THE SAME

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of Korean Patent Application No. 2010-0053391, filed on Jun. 7, 2010 in the Korean Intellectual Property Office, the disclosure of which is incorporated herein by reference.

BACKGROUND

1. Field

Embodiments relate to a washing machine having a pulsator device generating complex water currents.

2. Description of the Related Art

In general, a washing machine employing a pulsator washes laundry using a water current generated due to rotation of the pulsator.

In order to improve washing ability of the washing machine, the pulsator needs to generate a strong water current. However, when the pulsator generates the stronger water current, the possibility of damaging the laundry increases.

Performance of the washing machine is basically determined by the washing ability, but if the laundry is damaged during a washing process, excellent washing ability does not provide a favorable impression to users.

On the other hand, an amount of water consumed during washing is an important factor determining the performance of the washing machine.

If the amount of water consumed during washing increases, a long time is taken to carry out supply and drainage of water, thereby being uneconomical as well as elongating a washing time.

SUMMARY

Therefore, it is an aspect to provide a pulsator device which generates complex water currents so as to improve performance of a washing machine.

Additional aspects of the invention will be set forth in part in the description which follows and, in part, will be apparent from the description, or may be learned by practice of the invention.

In accordance with one aspect, a pulsator device for washing machines includes a first pulsator rotated around a rotary shaft, a shaft fixed to the first pulsator so as to revolve around the rotary shaft, and rotated together with rotation of the first pulsator, and a second pulsator rotatably connected to the shaft, wherein the shaft is disposed so as to have a biaxial inclination angle structure in the X-axis direction and the Y-axis direction with respect to an X-Y plane perpendicular to the rotary shaft.

The shaft may be disposed at a position eccentric from the rotary shaft to one side, and be inclined upward toward the outside in the radial direction of the first pulsator.

The first pulsator may include a recess formed on the upper portion thereof, and the second pulsator may be disposed in the recess.

The recess may be eccentrically disposed at one side in the radial direction of the first pulsator, and an upper end of a side wall forming the recess may be disposed adjacent to the outer circumferential surface of the second pulsator.

The pulsator device may further include a connector fixed to the upper surface of the first pulsator so as to be rotated together with rotation of the first pulsator, the connector may include an inclined plane perpendicular to the shaft, and the shaft may be extended so as to be perpendicular to the inclined plane.

The pulsator device may further include a clutch unit to intermit rotation of the second pulsator relative to the shaft according to a rotating direction of the second pulsator.

The clutch unit may include a clutch spring which is wound and unwound according to the rotating direction of the second pulsator.

The clutch unit may include a one-way clutch installed between the shaft and the second pulsator so as to cause the second pulsator to be rotated in any one direction out of the clockwise direction and the counterclockwise direction.

The clutch unit may include a latch structure to restrict rotation of the second pulsator, if the second pulsator is rotated in a first direction, and to allow the second pulsator to be rotated, if the second pulsator is rotated in an opposite direction to the first direction.

The latch structure may include at least one latch protrusion, and at least one forward and backward moving member supported by an elastic member and moving forwards and backwards, and the latch structure may restrict rotation of the second pulsator through latching of the at least one forward and backward moving member to the at least one latch protrusion, if the second pulsator is rotated in the first direction, and release the restriction of the second pulsator through application of pressure from the at least one latch protrusion to the at least one forward and backward moving member, if the second pulsator is rotated in the opposite direction to the first direction.

In accordance with another aspect, a washing machine includes a first pulsator rotated around a rotary shaft, a shaft inclined on the first pulsator so as to be rotated together with rotation of the first pulsator, a second pulsator rotatably connected to the shaft so as to be rotated in a first direction and in a second direction opposite to the first direction, and a clutch unit to intermit rotation of the second pulsator so as to cause the second pulsator to be rotated in any one direction out of the first direction and the second direction.

The shaft may be inclined with respect to the rotary shaft.

The shaft may be inclined upward toward the outside in the radial direction of the first pulsator.

The shaft may be disposed at a position eccentric from the center of rotation of the first pulsator.

The first pulsator may include a recess formed on the upper portion thereof and a side wall around the recess, and the second pulsator may be disposed in the recess.

The uppermost part of the side wall may be disposed adjacent to the uppermost part of the outer circumferential surface of the second pulsator inclined with respect to the horizontal direction.

The washing machine may further include a connector disposed between the first pulsator and the second pulsator, and fixed to the first pulsator so as to be rotated together with rotation of the first pulsator, the connector may include an inclined plane perpendicular to the shaft, and the shaft may be extended perpendicularly from the inclined plane.

The clutch unit may include a clutch spring wound so as to restrict rotation of the second pulsator, if the second pulsator is rotated in the first direction, and unwound so as to release the restriction of the second pulsator, if the second pulsator is rotated in the second direction.

The clutch unit may include a one-way clutch installed between the shaft and the second pulsator.

The clutch unit may include a latch structure including at least one latch protrusion, and at least one forward and back-

ward moving member moving forwards and backwards by an elastic member, so that the at least one latch protrusion and the at least one forward and backward moving member restrict each other, if the second pulsator is rotated in the first direction, and release the restriction, if the second pulsator is rotated in the second direction.

In accordance with another aspect, a pulsator device for washing machines includes a first pulsator rotated around a rotary shaft in a regular direction and the reverse direction, and a second pulsator selectively rotated according to a rotating direction of the first pulsator.

The pulsator device may further include a shaft connected to the first pulsator so as to be rotated together with rotation of the first pulsator, and inclined, and the second pulsator may be rotatably connected to the shaft.

The pulsator device may further include a clutch unit to restrict rotation of the second pulsator relative to the shaft, if the first pulsator is rotated in any one direction out of the regular direction and the reverse direction.

The second pulsator may be rotated integrally with the first pulsator to perform a rotating movement, if the rotation of the second pulsator is restricted, and perform a wobbling movement during rotation of the first pulsator, if the restriction of the rotation of the second pulsator is released.

In accordance with a further aspect, a pulsator device for washing machines includes a first pulsator rotated around a rotary shaft, and provided with a plurality of planes formed on the upper surface thereof and inclined at different angles with respect to the horizontal plane, a plurality of recesses, each of which is formed on each inclined plane, a plurality of shafts, each of which is disposed on the bottom of each recess so as to have a biaxial inclination angle structure, and a plurality of second pulsators, each of which is rotatably provided on each shaft.

The plurality of second pulsators may be disposed so as to uniformly divide the upper surface of the first pulsator.

The pulsator device may further include a clutch unit connected to at least one of the plurality of shafts so as to intermit rotation of the second pulsator according to a rotating direction of the second pulsator rotatably connected to each shaft.

The clutch unit may include a clutch spring wound or unwound according to the rotating direction of the second pulsator.

The clutch unit may include a one-way clutch installed between the shaft and the second pulsator.

The clutch unit may include a latch structure including at least one latch protrusion, and at least one forward and backward moving member supported by an elastic member and moving forwards and backwards, and the latch structure may restrict rotation of the second pulsator through latching of the at least one forward and backward moving member to the at least one latch protrusion, if the second pulsator is rotated in a first direction, and release the restriction of the second pulsator through application of pressure from the at least one latch protrusion to the at least one forward and backward moving member, if the second pulsator is rotated in an opposite direction to the first direction.

BRIEF DESCRIPTION OF THE DRAWINGS

These and/or other aspects will become apparent and more readily appreciated from the following description of the embodiments, taken in conjunction with the accompanying drawings of which:

FIG. **1** is a longitudinal-sectional view illustrating a schematic structure of a washing machine in accordance with one embodiment;

FIG. **2** is a perspective view of a pulsator device in an assembled state in accordance with the embodiment;

FIG. **3** is an exploded perspective view of the pulsator device in accordance with the embodiment;

FIG. **4** is an enlarged view of the portion A of FIG. **1**;

FIGS. **5**A and **5**B are views illustrating inclination angles of a shaft in accordance with the embodiment;

FIG. **6** is a longitudinal-sectional view taken along the line I-I' of FIG. **2**;

FIGS. **7** and **8** are views illustrating operation of a clutch spring in accordance with the embodiment;

FIG. **9** is a perspective view illustrating a clutch unit in accordance with another embodiment;

FIG. **10** is a longitudinal-sectional view illustrating an assembled state of the clutch unit of FIG. **9**;

FIG. **11** is a transversal-sectional view of the clutch unit connected between a shaft and a bearing housing of FIG. **9**;

FIG. **12** is a transversal-sectional view of a clutch unit in accordance with another embodiment;

FIG. **13** is a view illustrating an operating state of a first pulsator and a second pulsator in accordance with the embodiment;

FIG. **14** is a longitudinal-sectional view illustrating an operating state of the second pulsator in accordance with the embodiment; and

FIG. **15** is an exploded perspective view illustrating a pulsator device in accordance with a further embodiment.

DETAILED DESCRIPTION

Reference will now be made in detail to the embodiments, examples of which are illustrated in the accompanying drawings, wherein like reference numerals refer to like elements throughout.

FIG. **1** is a longitudinal-sectional view illustrating a schematic structure of a washing machine in accordance with one embodiment.

As shown in FIG. **1**, a washing machine **1** includes a main body **10** forming an external appearance of the washing machine **1**, a tub **20** disposed within the main body **10**, a spin basket **30** rotatably disposed within the tub **20**, and a pulsator device **100** disposed within the spin basket **30** to generate complex water currents.

An inlet **11** through which laundry is put into the spin basket **30** is formed through the upper surface of the main body **10**, and the inlet **11** is opened and closed by a door **12** installed at the upper surface of the main body **10**.

The tub **20** is supported by the main body **10** using suspension devices **40** connecting the lower portion of the outer surface of the tub **20** to the upper portion of the inner surface of the main body **10**.

A water supply pipe **52** to supply wash water to the tub **20** is installed above the tub **20**.

One end of the water supply pipe **52** is connected to an external water supply source (not shown), and the other end of the water supply pipe **52** is connected to a detergent supply device **54**.

Water supplied through the water supply pipe **52** is supplied to the inside of the tub **20** together with a detergent via the detergent supply device **54**.

A drain device **60** to discharge the wash water stored in the tub **20** to the outside of the washing machine **1** is installed under the tub **20**.

The drain device **60** includes a drain pipe **62** connected to the lower portion of the tub **20**, and a drain valve **64** installed on the drain pipe **62**.

A drain pump (not shown) to forcibly discharge the wash water from the tub **20** is installed in the drain pipe **62**.

The spin basket **30** is provided in a cylindrical shape, the upper surface of which is opened, and a plurality of dehydration holes **32** is formed through the side surface of the spin basket **30**. A balancer **34** to allow the spin basket **30** to be stably rotated during high-speed rotation of the spin basket **30** is installed on the upper portion of the spin basket **30**.

A pumping duct **36** to circulate the wash water in the spin basket **30** is installed on the inner surface of the spin basket **30**, and discharge holes **37** to discharge the wash water are formed through the pumping duct **36**.

A driving device **70** is installed under the tub **20**. The driving device **70** includes a motor **72**, a power transmission device **74**, a clutch **76**, and a drive shaft **78**. The drive shaft **78** is connected with the pulsator device **100**, and transmits power of the motor **72** to the pulsator device **100**.

The power of the motor **72** is transmitted to the clutch **76** through the power transmission device **74**. The power transmission device **74** includes pulleys **74***a*, and a belt **74***b* connecting the pulleys **74***a*. The clutch **76** intermits the power of the motor **72**, thereby allowing the spin basket **30** and the pulsator device **100** to be rotated simultaneously, or the pulsator device **100** to be rotated while the spin basket **30** remains still.

FIG. **2** is a perspective view of a pulsator device in an assembled state in accordance with the embodiment, FIG. **3** is an exploded perspective view of the pulsator device in accordance with the embodiment, FIG. **4** is an enlarged view of the portion A of FIG. **1**, and FIGS. **5**A and **5**B are views illustrating inclination angles of the shaft in accordance with the embodiment.

With reference to FIG. **2**, in order to describe directions in the embodiment, the X-axis direction (first direction), the Y-axis direction (second direction), and the Z-axis direction (third direction) are set. The Z-axis direction is a direction parallel with a direction of gravity, the X-axis direction is a direction perpendicular to the Z-axis direction, and the Y-axis direction is a direction perpendicular to the X-axis direction and the Z-axis direction.

Here, the X-axis direction means a first direction parallel with the leftward and rightward direction of the main body **10**, and the Y-axis direction means a second direction parallel with the forward and backward direction of the main body **10**.

With reference to FIGS. **1** to **4**, the pulsator device **100** includes a first pulsator **200** to form a general horizontally rotating water current, a second pulsator **300** connected to the upper portion of the first pulsator **200** to form a wobbling water current which vertically flows and/or a rotating water current, and a shaft **400** connecting the first pulsator **200** and the second pulsator **300**.

At least a part of the first pulsator **200** may be rotatably disposed on the bottom surface of the spin basket **30**. The first pulsator **200** includes a shaft connection part **210** formed at the center thereof, and the drive shaft **78** of the driving device **70** is connected with the shaft connection part **210**.

The drive shaft **78** functions as a rotary shaft of the first pulsator **200**. When power of the motor **72** is transmitted to the drive shaft **78** through the clutch **76**, the first pulsator **200** is rotated around the drive shaft **78**.

The first pulsator **200** is provided with a space to receive the second pulsator **300** so as to prevent damage to laundry due to jamming of the laundry in the lower portion of the second pulsator **300** during a wobbling movement of the second pulsator **300**.

For this purpose, a recess **220** is formed on the upper surface of the first pulsator **200**, and a side wall **223** is formed around the recess **220**. The recess **220** is disposed so as to be eccentric to one side in the radial direction of the first pulsator **200**.

Holes **221** are disposed on the bottom of the recess **220** in the circumferential direction, and a plurality of pumping blades **227** is radially disposed on the rear surface of the first pulsator **200**.

Therethrough, when laundry is washed, wash water around the first pulsator **200** is introduced to the rear surface of the first pulsator **200** through the holes **221** of the first pulsator **200**, and is pressurized outwardly in the radial direction of the first pulsator **200** by the pumping blades **227**.

The wash water pressurized by the pumping blades **227** is guided into the pumping duct **36** (with reference to FIG. **1**) through a channel (not shown) formed on the lower portion of the spin basket **30**, and is discharged to the inside of the spin basket **30** through the discharge holes of the pumping duct **36**.

As shown in FIG. **4**, the shaft **400** is fixed to the first pulsator **200** so as to revolve around an axis **78***a* of the drive shaft **78** during the rotation of the first pulsator **200**.

For this purpose, an axis **401** of the shaft **400** is disposed at a position eccentric from the axis **78***a* of the drive shaft **78**. That is, a point **403** where the axis **401** of the shaft **400** and the first pulsator **200** meet is disposed at a position separated from the axis **78***a* of the drive shaft **78** by a designated distance D.

Therefore, if the pulsator **200** is rotated together with rotation of the drive shaft **78**, the shaft **400** fixed to the first pulsator **200** is rotated together with the rotation of the pulsator **200** while revolving around the axis **78***a* of the drive shaft **78**. Hereinafter, a configuration of such a shaft **400** will be described in more detail.

The shaft **400** is fixed to the first pulsator **200** through a connector **500**. For this purpose, a connector connection part **230** connected with the connector **500** is provided on the recess **220** of the first pulsator **200**.

As shown in FIG. **3**, the connector connection part **230** includes a guide rib **231** protruded from the bottom of the recess **220**. The guide rib **231** serves both to guide a connection position of the connector **500** and to stably support the inner surface of the connector **500** under the condition that the connector **500** is connected with the connector connection part **230**.

The shaft connection part **210** is disposed at the inside of the guide rib **231**, and the shaft connection part **210** and the guide rib **231** are connected by reinforcing ribs **232**.

A through hole **211** to connect the connector **500** and the drive shaft **78** is formed through the upper surface of the shaft connection part **210**.

At least one fastening boss **233** is provided on the connector connection part **231**, and a fastening hole **234** is formed on each fastening boss **233**.

The connector **500** is disposed between the first pulsator **200** and the second pulsator **300**, and is connected with the first pulsator **200** so as to be rotated together with rotation of the first pulsator **200**. The connector **500** is fixed to the first pulsator **200** through fastening members, such as bolts.

For this purpose, the connector **500** includes connection holes **510** corresponding to the fastening holes **234** of the connector connection part **230** and the through hole **211** of the shaft connection part **210**.

Although this embodiment illustrates that the connector **500** is formed as a separate part, the connector **500** is not limited thereto. That is, the shaft **400** and/or the connector **500** may be formed integrally with the first pulsator **200**, or only the shaft **400** may be provided on the first pulsator **200**.

As shown in FIGS. **3** and **4**, the shaft **400** fixed to the connector **500** so as to be disposed at a position eccentric from

the drive shaft **78** to one side is inclined with respect to the drive shaft **78**. Thereby, the second pulsator **300** connected to the shaft **400** is inclined with respect to the horizontal direction, thus allowing a random position of the second pulsator **300** to move in the vertical direction during rotation of the first pulsator **200**.

For this purpose, an inclined plane **520** which is inclined with respect to the horizontal direction is provided on the connector **500**, and the shaft **400** is extended upwards so as to be perpendicular to the inclined plane **520**.

The inclined plane **520** has a biaxial inclination angle structure having designated inclination angles in directions of the X-axis and the Y-axis, which form a right angle on an X-Y plane perpendicular to the drive shaft **78**.

That is, the inclined plane **520** has a first inclination angle θ_1 in the X-axis direction, as shown in FIG. **5**A, and has a second inclination angle θ_2 in the Y-axis direction, as shown in FIG. **5**B.

Thereby, the shaft **400** extended so as to be perpendicular to the inclined plane **520** also has a biaxial inclination angle structure having designated inclination angles θ_1 and θ_1 in the X-axis direction and the Y-axis direction on the X-Y plane perpendicular to the drive shaft **78**.

Therefore, the shaft **400** is disposed at a position eccentric from the drive shaft **78** by the designated distance D, and is inclined upwards in a direction being distant from the drive shaft **78**, i.e., in a direction between the X-axis and the Y-axis.

The first inclination angle θ_1 determines an ascending and descending range of the second pulsator **300** during the wobbling movement of the second pulsator **300**, and the second inclination angle θ_2 determines a contact area of the surface of the second pulsator **300** with laundry during the rotating movement of the second pulsator **300**. A detailed description thereof will be given later.

Although this embodiment illustrates that the shaft **400** is inclined upward toward the outside in the radial direction of the first pulsator **200**, the shaft **400** may be inclined upward toward the inside in the radial direction of the first pulsator **200**, i.e., toward the drive shaft **78**.

However, in terms of an increase in a distance from the center O of the second pulsator **300** rotatably connected to the shaft **400** to the axis **78***a* of the drive shaft **78**, i.e., a revolving radius r of the second pulsator **300**, the shaft **400** may be inclined upward toward the outside in the radial direction of the first pulsator **200**. That is, a distance between the center of the first pulsator **200** and the center of the second pulsator **300** may be varied.

Further, although this embodiment illustrates that the shaft **400** is disposed on the inclined plane **520** of the connector **500**, if the shaft **400** alone is formed on the upper surface of the second pulsator **300**, the shaft **400** may be extended vertically from a position eccentric from the drive shaft **78** by the designated distance D and then be inclined so as to have both the first inclination angle θ_1 in the X-axis direction and the second inclination angle θ_2 in the Y-axis direction.

With reference to FIGS. **3** and **4**, the second pulsator **300** is rotatably connected to the shaft **400**. The second pulsator **300** is not restricted by the shaft **400** so that the second pulsator **300** and the shaft **400** may be rotated relative to each other.

A connection boss **310** having a shaft connection hole **311**, into which the shaft **400** is inserted, is provided on the center of the second pulsator **300**. The connection boss **310** is supported by a stepped plane **405** provided on the lower portion of the shaft **400** protruded from the inclined plane **520** of the connector **500**. The stepped plane **405** is formed on the upper surface of a support boss **404** extended vertically from the inclined plane **520**.

A bearing **420** is disposed between the inner surface of the shaft connection hole **311** and the shaft **400** so as to allow the second pulsator **300** to be smoothly rotated relative to the shaft **400**.

A bearing housing **410** is fixed to the inside of the shaft connection hole **311**, and the bearing **420** is fixed to the inner surface of the bearing housing **410**. The bearing **420** may be an oilless bearing.

The bearing **420** includes an upper bearing **421** fixed to the upper portion of the bearing housing **410**, and a lower bearing **423** fixed to the lower portion of the bearing housing **410**. If the bearing **420** is divided into two bearings **421** and **423**, as described above, assembly efficiency and accuracy of the bearing **420** are improved.

The lower bearing **423** is provided with a flange part **425** disposed between the lower surface of the connection boss **310** and the stepped plane **405** of the shaft **400**. The flange part **425** allows the connection boss **310** of the second pulsator **300** to be smoothly rotated on the stepped plane **405** of the connector **500**.

A cap receipt part **313** is provided on the upper surface of the connection boss **310** of the second pulsator **300**, and a cap **314** is installed in the cap receipt part **313**.

Through holes **315** to circulate wash water are formed through the second pulsator **300**. Wash water around the second pulsator **300** is introduced into the lower portion of the second pulsator **300** through the through holes **315**.

Blades **316** are protruded from the upper surface of the second pulsator **300**. The blades **316** are disposed in the circumferential direction of the second pulsator **300**. The blades **316** rub against laundry so as to allow the laundry to induce rotation of the second pulsator **300** (using the shaft **400** as a central axis).

If the second pulsator **300** is axially connected to the shaft **400**, the second pulsator **300** is disposed so as to have a biaxial inclination angle structure with respect to the first pulsator **200** in the X-axis and the Y-axis directions.

If the second pulsator **300** is disposed so as to have the biaxial inclination angle structure with respect to the first pulsator **200**, a contact area of the second pulsator **300** with laundry during rotation of the second pulsator **300** is greater than that of a second pulsator, disposed so as to have a mono-axial inclination angle structure with the first pulsator **200** in the X-axis or the Y-axis direction, with laundry during rotation of the second pulsator.

Therefore, if the second pulsator **300** is rotated integrally with the first pulsator **200**, the second pulsator **300** functions as a blade of the first pulsator **200** and thus the first pulsator **200** does not require any separate blade to form a wash water current.

Since the second pulsator **300** is connected to the shaft **400** and is inclined, a random point on the upper surface of the second pulsator **300** moves in a revolving direction during rotation of the first pulsator **200**. Further, the second pulsator rotatably connected to the shaft **400** is not restricted by the shaft **400**, and thus is rotated relative to the shaft **400** due to friction with laundry. In this case, the random point on the upper surface of the second pulsator **300** moves in the vertical direction while revolving, thereby forming both a rotating water current and a water current in the vertical direction or the inclination direction. As shown in FIG. **14**, during rotation of the first pulsator **200**, the shaft **400** revolves around the axis **78***a* of the drive shaft **78**, and if a weight of laundry is applied to the second pulsator **300**, the second pulsator **300** is rotated and thus performs a rotating movement and a vertical movement (arrow H) due to the revolution of the shaft **400** and the rotation of the second pulsator **300**.

Such a movement of the second pulsator **300** generates water currents in the rotating direction and the vertical direction within the spin basket **30**.

FIG. **6** is a longitudinal-sectional view taken along the line I-I' of FIG. **2**. As shown in FIG. **6**, the side wall **223** forming the recess **220** of the first pulsator **20** is extended to a position adjacent to an outer circumferential surface **317** of the second pulsator **300** so as to reduce a gap between the first pulsator **200** and the second pulsator **300**, if the second pulsator **300** is connected to the shaft **400**. That is, an upper surface **318** adjacent to the outer circumferential surface **317** of the second pulsator **300** is smoothly connected with an upper end **224** of the side wall **223** without a great height difference.

The side wall **223** of the first pulsator **200** includes a step forming part **225** extended toward the inside in the radial direction of the first pulsator **200**, and the second pulsator **300** includes at least one rib, i.e., ribs **321** and **322** in this embodiment, protruded from the edge of the second pulsator **300** toward the step forming part **225**. The step forming part **225** and the ribs **321** and **322** prevent laundry or foreign substances from being jammed between the side wall **223** of the first pulsator **200** and the second pulsator **300**.

The least one rib may include a first rib **321** adjacent to the side wall **223** of the first pulsator **200**, and a second rib **322** disposed at the inside of the first rib **321** under the condition that the second rib **322** is separated from the first rib **321** by a designated interval.

In order to enhance a foreign substance introduction preventing function, a protrusion **226** is formed on the side wall **223** of the first pulsator **200**. The protrusion **226** is adjacent to the first rib **321** and the second rib **322** of the second pulsator **300**, and is protruded toward the second pulsator **300**. The protrusion **226** may be protruded between the first rib **321** and the second rib **322** of the second pulsator **300**.

Therethrough, although the second pulsator **300** received in the recess **220** eccentrically disposed on the first pulsator **200** is rotated, there is no gap between the upper end **224** of the side wall **223** and the outer circumferential surface **317** of the second pulsator **300**, thereby preventing laundry from being jammed in the second pulsator **300**.

Further, the upper end **224** of the side wall **23** forming the recess **220** of the first pulsator **200** may be higher than the upper surface **318** of the second pulsator **300**.

The pulsator device **100** in accordance with this embodiment further includes a clutch unit **600** restricting rotation of the second pulsator **30** relative to the shaft **400** according to a rotating direction of the first pulsator **200**.

With reference to FIGS. **3** and **4**, the clutch unit **600** serves to intermit rotary force of the second pulsator **300** relatively rotatably connected to the shaft **400**, and includes a clutch spring **610**.

The clutch spring **610** is configured such that a central part **611** is wound plural times and a pair of ends **613** is protruded at different angles. A part of the central part **611** of the clutch spring **610** is fixed to the outer surface of the support boss **404** protruded from the inclined plane **520** of the connector **500**, and the remaining part of the central part **611** of the clutch spring **610** is fixed to the outer surface of the connection boss **310**.

That is, the clutch spring **610** is disposed concentrically with the support boss **404** and the connection boss **310**, and thus is selectively tightened to the outer circumferential surfaces of the support boss **404** and the connection boss **310** according to a rotating direction of the connection boss **310**, thereby contacting or being released from the support boss **404** and the connection boss **310**.

Thereby, if the second pulsator **300** is rotated in a direction of winding the clutch spring **610**, as shown in FIG. **7**, the clutch spring **610** firmly tightens the outer circumferential surfaces of the support boss **404** and the shaft **400** and thus the second pulsator **300** is not rotated around the shaft **400**. On the other hand, if the second pulsator **300** is rotated in a direction of unwinding the clutch spring **610**, as shown in FIG. **8**, force enabling the clutch spring **610** to tighten the outer circumferential surfaces of the support boss **404** and the shaft **400** is decreased and thus the second pulsator **300** is rotated.

Although this embodiment illustrates that the outer circumferential surface of the connection boss **310** is fitted into the central part **611** of the clutch spring **610**, such a connection position of the second pulsator **300** with the clutch spring **610** may be changed as long as the clutch spring **610** is connected to a part (for example, the bearing housing) which may restrict rotation of the second pulsator **300**.

FIG. **9** is a perspective view illustrating a clutch unit in accordance with another embodiment, FIG. **10** is a longitudinal-sectional view illustrating an assembled state of the clutch unit of FIG. **9**, and FIG. **11** is a transversal-sectional view of the clutch unit connected between a shaft and a bearing housing of FIG. **9**.

With reference to FIGS. **9** to **11**, a second pulsator **300** is installed on a shaft **400** through a one-way clutch **630**. Thus, the second pulsator **300** is provided such that it may be rotated in any one direction out of a first direction and a second direction.

Here, the first direction means any one of the clockwise direction and the counterclockwise direction, and the second direction means the other one of the clockwise direction and the counterclockwise direction.

In this embodiment, the one-way clutch **630** includes a first body **631** formed in a cylindrical shape, roller installation grooves **635** provided on the outer circumferential surface of the first body **631** and having a depth gradually increasing in the circumferential direction, roller bearings **637** installed in the roller installation grooves **635**, and a second body **633** provided at the outside of the first body **631** and formed in a cylindrical shape.

The first body **631** is fixed to the outer circumferential surface of the shaft **400** by press fit, and the second body **633** is fixed to the inner circumferential surface of the bearing housing **410** by press fit.

Through such a configuration, the second pulsator **300** is rotated around the shaft **400** only when the second pulsator **300** is rotated in the first direction.

Although this embodiment illustrates that the second body **633** is fixed to the inner circumferential surface of the bearing housing **410** by press fit, the fixing method of the second body **633** to the bearing housing **410** is not limited thereto. That is, the second body **633** may be fixed to the inner circumferential surface of the connection boss **310**, or the second body **633** may be formed integrally with the bearing housing **410** or the connection boss **310**.

Further, although this embodiment illustrates the one-way clutch **630**, other types of clutches may be used and, as needed, various types of one-way clutches may be used.

FIG. **12** illustrates a clutch unit in accordance with another embodiment.

A clutch unit **650** in accordance with this embodiment is formed in a latch structure. With reference to FIG. **12**, the clutch unit **650** includes a first body **651** formed in a cylindrical shape, and a second body **565** having a greater diameter than that of the first body **651** and disposed at the outside of the first body **651**.

The inner circumferential surface of the first body **651** is fixed to the outer circumferential surface of the shaft **400** by press fit, and the outer circumferential surface of the second body **656** is fixed to the inner circumferential surface of the connection boss **310** or the bearing housing **410**.

At least one latch protrusion **657**, separated in the circumferential direction, is provided on the inner circumferential surface of the second body **656**, and at least one forward and backward moving member **653**, which is movable forwards and backwards in the radial direction, is provided on the outer circumferential surface of the first body **651**.

Each latch protrusion **657** includes a first guide part **658** inclined in the rotating direction (first direction) of the second body **656**, and a first latch part **659** extended from the end of the first guide part **658** in the radial direction of the second body **656**.

Each forward and backward moving member **653** includes a second guide part **654** corresponding to the first guide part **658** of the latch protrusion **657**, and a second latch part **655** corresponding to the first latch part **659** of the latch protrusion **657**.

Receipt parts **652**, each of which receives the forward and backward moving member **653**, are provided on the first body **651**, and an elastic member **660** to elastically support the forward and backward moving member **653** is provided in each of the receipt parts **652**.

Thereby, if the second body **656** is rotated in the first direction (clockwise direction), the first latch parts **659** of the latch protrusions **657** are restricted by the second latch parts **655** of the forward and backward moving members **653** and thus restrict rotation of the second body **656**, and if the second body **656** is rotated in the second direction (counterclockwise direction), the first guide parts **658** of the latch protrusions **657** are guided by the second guide parts **654** of the forward and backward moving members **653** and thus apply pressure the forward and backward moving members **653** so as to enable smooth rotation of the second body **656**.

Although this embodiment illustrates that the forward and backward moving members **653** are provided on the first body **651** and the latch protrusions **657** are provided on the second body **656**, it would be appreciated by those skilled in the art that such positions of the forward and backward members **653** and the latch protrusions **657** may be interchanged without departing from the principles and spirit of the invention.

Further, although this embodiment illustrates that the clutch unit **650** of the latch structure includes the first body **651** and the second body **656** which are separately provided, it would be appreciated by those skilled in the art that the first body **651** may be formed integrally with the shaft **400** and the second body **656** may be formed integrally with the connection boss **310** or the bearing housing **410**.

Hereinafter, operation of the pulsator device with the clutch unit will be described. Here, the clutch unit including the clutch spring is exemplarily described.

FIGS. **13** and **14** are views illustrating operation of a pulsator device of a washing machine in accordance with one embodiment. In this embodiment, the clutch spring **610** causing the shaft **400** to restrict rotation of the second pulsator **300** during rotation in the first direction (clockwise direction) and causing the shaft **400** to enable free rotation of the second pulsator **300** during rotation in the second direction (counterclockwise direction) will be exemplarily described.

When a user puts laundry into the spin basket **30**, supplies a detergent into the detergent supply device **54** and then operates the washing machine **1**, wash water is supplied to the inside of the spin basket **30** through the water supply pipe **52**. When water supply is completed, the motor **72** is operated to drive the pulsator device **100**.

Power of the motor **72** rotates the first pulsator **200** through the drive shaft **78**. The first pulsator **200** is rotated in the first direction (clockwise direction) or in the second direction (counterclockwise direction) according to regular rotation or reverse rotation of the drive shaft **78**, as shown in FIG. **13**.

If the second pulsator **300** is rotated in the first direction, i.e., in a direction of winding the clutch spring **610**, the clutch spring **610** tightens the support boss **404** and the connection boss **310**, as shown in FIG. **7**, and thereby, rotation of the second pulsator **300** about the shaft **400** is restricted and thus the first pulsator **200** and the second pulsator **300** restrict each other.

Therefore, the second pulsator **300** is rotated integrally with rotation of the first pulsator, thus performing a rotating movement without a vertical movement.

In this case, since the second pulsator **300** is disposed so as to have the biaxial inclination structure with respect to the first pulsator **200**, the second pulsator **300** serves as a large blade of the first pulsator **200** during rotation of the first pulsator **200**.

If the second pulsator **300** is rotated in the second direction, i.e., in a direction of unwinding the clutch spring **610**, force enabling the clutch spring **610** to tighten the support boss **404** and the connection boss **310** is decreased and thus the connection boss **310** is freely rotated around the shaft **400**.

Further, since the second pulsator **300** is disposed on the first pulsator **200** so as to be inclined with respect to the first pulsator **200**, a random point on the upper surface of the second pulsator **300** moves in the vertical direction according to rotation of the first pulsator **200**, and thereby a water current in the vertical direction is generated in the spin basket **30**.

That is, as shown in FIG. **14**, when the first pulsator **200** is rotated, the shaft **400** connected to the first pulsator **200** is rotated around the axis **78***a* of the drive shaft **78**. At this time, when a weight of the laundry in the spin basket **30** is applied to the second pulsator **300**, the second pulsator **300** moves while being rotated relative to the shaft **400**. Therefore, the random point on the upper surface of the second pulsator **300** moves in the vertical direction, thus generating a water current in the vertical direction.

When the weight of the laundry is applied to the second pulsator **300**, the shaft **400** moves while being rotating relative to the second pulsator **300**, and thus the weight applied to the second pulsator **300** is not transmitted to the motor **72**. Therefore, load applied to the motor **72** may be reduced.

As described above, the pulsator device **100** in accordance with this embodiment generates only a rotating movement of the first pulsator **200** in the same manner as a conventional pulsator, or simultaneously generates both the rotating movement and a vertical movement due to the rotating movement of the second pulsator **300**, thereby generating complex water currents and thus allowing the washing machine **1** to effectively wash the laundry with only a small amount of water.

FIG. **15** is an exploded perspective view illustrating a pulsator device in accordance with a further embodiment. Some parts in this embodiment which have the same functions as those in the previous embodiments are thus denoted by the same reference numerals even though they are depicted in different drawings, and a detailed description thereof will thus be omitted because it is considered to be unnecessary.

With reference to FIG. **15**, a plurality of recesses **711** is formed on the upper surface of a first pulsator **710**, and a side wall **715** is formed around each of the recesses **711**.

The recesses **711** are respectively provided on planes **716**, **717**, and **718** formed on the upper surface of the first pulsator **710**, and the planes **716**, **717**, and **718** are inclined at different angle with respect to the horizontal plane. Such a first pulsator **710** has an approximately tetrahedral shape due to the inclined planes **716**, **717**, and **718** on the upper surface of the first pulsator **710**.

A second pulsator **730** is received in each of the plural recesses **711**. The second pulsators **730** are connected with the first pulsator **710** through connectors **720** connected to the recesses **711**.

A connection protrusion **721** is provided on the lower portion of the connector **720**, and a shaft **723** having a biaxial inclination angle structure is provided on the upper portion of the connector **720**.

The shaft **723** has the biaxial inclination angle structure having designated inclination angles in directions of the X-axis and the Y-axis on an X-Y plane parallel with the bottom of the recess **711**.

A connection hole **713** to which the connection protrusion **721** of the connector **720** is connected by press fit is provided on the recess **711**. The second pulsator **730** is rotatably connected to the shaft **723**.

Thereby, the washing machine further improves washing ability and reduces water consumption through complex currents of wash water in the spin basket **30** generated by the first pulsator **710** and the plural second pulsators **730**.

Although not shown in this embodiment, a clutch unit to intermit rotation of the second pulsator **730** so as to rotate the second pulsator **730** only in one direction may be provided on the shaft **723**.

As is apparent from the above description, a washing machine in accordance with one embodiment effectively washes laundry with a small amount of water using a pulsator device generating complex water currents, thereby being advantageous in terms of washing performance and water consumption.

Although a few embodiments have been shown and described, it would be appreciated by those skilled in the art that changes may be made in these embodiments without departing from the principles, and spirit of the invention, the scope of which is defined in the claims and their equivalents.

What is claimed is:

1. A pulsator device for washing machines comprising:
- a first pulsator rotated around a rotary shaft;
- a shaft fixed to the first pulsator so as to revolve around the rotary shaft, and rotated together with a rotation of the first pulsator; and
- a second pulsator rotatably connected to the shaft,
- wherein the shaft is disposed so as to have a biaxial inclination angle structure in an X-axis direction and a Y-axis direction with respect to an X-Y plane perpendicular to the rotary shaft, and
- wherein the first pulsator includes a recess formed on an upper portion thereof, and the second pulsator is disposed in the recess, the recess being eccentrically disposed in a radial direction of the first pulsator.

2. The pulsator device according to claim **1**, wherein the shaft is disposed at a position eccentric from the rotary shaft to one side, and is inclined upward toward an outside of the pulsator device in a radial direction of the first pulsator.

3. The pulsator device according to claim **1**, wherein an upper end of a side wall forming the recess is disposed adjacent to an outer circumferential surface of the second pulsator.

4. The pulsator device according to claim **1**, further comprising a connector fixed to an upper surface of the first pulsator so as to be rotated together with the rotation of the first pulsator,
- wherein the connector includes an inclined plane perpendicular to the shaft, and the shaft is extended so as to be perpendicular to the inclined plane.

5. The pulsator device according to claim **1**, further comprising a clutch unit to intermit rotation of the second pulsator relative to the shaft according to a rotating direction of the second pulsator.

6. The pulsator device according to claim **5**, wherein the clutch unit includes a clutch spring which is wound and unwound according to the rotating direction of the second pulsator.

7. The pulsator device according to claim **5**, wherein the clutch unit includes a one-way clutch installed between the shaft and the second pulsator so as to cause the second pulsator to be rotated in any one direction out of the clockwise direction and the counterclockwise direction.

8. The pulsator device according to claim **5**, wherein the clutch unit includes a latch structure to restrict rotation of the second pulsator, if the second pulsator is rotated in a first direction, and to allow the second pulsator to be rotated, if the second pulsator is rotated in an opposite direction to the first direction.

9. The pulsator device according to claim **8**, wherein:
- the latch structure includes at least one latch protrusion, and at least one forward and backward supported by an elastic member and moving member moving forwards and backwards; and
- the latch structure restricts rotation of the second pulsator through latching of the at least one forward and backward moving member to the at least one latch protrusion, if the second pulsator is rotated in the first direction, and releases the restriction of the second pulsator through application of pressure from the at least one latch protrusion to the at least one forward and backward moving member, if the second pulsator is rotated in the opposite direction to the first direction.

10. A washing machine comprising:
- a first pulsator rotated around a rotary shaft;
- a shaft connected to the first pulsator so as to be rotated together with a rotation of the first pulsator, and inclined;
- a second pulsator rotatably connected to the shaft so as to be rotated in a first direction and in a second direction opposite to the first direction; and
- a clutch unit to intermit rotation of the second pulsator so as to cause the second pulsator to be rotated in any one direction out of the first direction and the second direction, and
- wherein the first pulsator includes a recess formed on an upper portion thereof, and the second pulsator is disposed in the recess, the recess being eccentrically disposed in a radial direction of the first pulsator.

11. The washing machine according to claim **10**, wherein the shaft is inclined with respect to the rotary shaft.

12. The washing machine according to claim **10**, wherein the shaft is inclined upward toward an outside of the washing machine in a radial direction of the first pulsator.

13. The washing machine according to claim **10**, wherein the shaft is disposed at a position eccentric from a center of rotation of the first pulsator.

14. The washing machine according to claim **10**, further comprising a connector disposed between the first pulsator and the second pulsator, and fixed to the first pulsator so as to be rotated together with the rotation of the first pulsator,

wherein the connector includes an inclined plane perpendicular to the shaft, and the shaft is extended perpendicularly from the inclined plane.

15. The washing machine according to claim **10**, wherein the clutch unit includes a clutch spring wound so as to restrict rotation of the second pulsator, if the second pulsator is rotated in the first direction, and unwound so as to release the restriction of the second pulsator, if the second pulsator is rotated in the second direction.

16. The washing machine according to claim **10**, wherein the clutch unit includes a one-way clutch installed between the shaft and the second pulsator.

17. The washing machine according to claim **10**, wherein the clutch unit includes a latch structure including at least one latch protrusion, and at least one forward and backward moving member moving forwards and backwards by an elastic member, so that the at least one latch protrusion and the at least one forward and backward moving member restrict each other, if the second pulsator is rotated in the first direction, and release the restriction, if the second pulsator is rotated in the second direction.

18. A pulsator device for washing machines comprising:

a first pulsator rotated around a rotary shaft in a regular direction and a reverse direction;

a second pulsator selectively rotated according to a rotating direction of the first pulsator, and

a shaft connected to the first pulsator so as to be rotated together with a rotation of the first pulsator, and inclined,

wherein the second pulsator is rotatably connected to the shaft, and

wherein the first pulsator includes a recess formed on an upper portion thereof, and the second pulsator is disposed in the recess, the recess being eccentrically disposed in a radial direction of the first pulsator.

19. The pulsator device according to claim **18**, further comprising a clutch unit to restrict rotation of the second pulsator relative to the shaft, if the first pulsator is rotated in any one direction out of the regular direction and the reverse direction.

20. The pulsator device according to claim **19**, wherein the second pulsator is rotated integrally with the first pulsator to form a rotating water current, if a rotation of the second pulsator is restricted, and performs a rotating movement to form a vertical water current during the rotation of the first pulsator, if the restriction of the rotation of the second pulsator is released.

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UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 9,194,071 B2
APPLICATION NO. : 13/064764
DATED : November 24, 2015
INVENTOR(S) : Dong Pil Seo et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

ON THE TITLE PAGE

Item 75, Column 1, Line 6

Delete "Hwanseong-si" and insert -- Hwaseong-si --, therefor.

Signed and Sealed this
Twenty-ninth Day of March, 2016

Michelle K. Lee

Michelle K. Lee
Director of the United States Patent and Trademark Office